local 3 direction was defined out of the plane. The material properties were defined as follows:

$E_{11} = 0.24$ GPa	$\nu_{12} = 0.09$	$G_{12} = 0.60$ GPa
$E_{22} = 1.20$ GPa	$\nu_{23} = 0.09$	$G_{23} = 0.60$ GPa
$E_{33} = 0.24$ GPa	$\nu_{31} = 0.09$	$G_{31} = 0.60$ GPa

A simulation was performed for the case of 30.0 N constant tension, and the EFL was computed. The EFL was computed from the circumferential strain according to Equation 5.1, with an initial EFL value of 1.0%. The initial EFL for the buffering trials was not known so the value was approximated to achieve a reasonable agreement with the experiment. The computed and the experimentally measured EFL distribution are shown in Figure 30. The length scale in the plot has been normalized to one. The results show good agreement between model and experiment except for a slight deviation on the right portion of the curves. The EFL values generated by the model are computed from a single strain point in each layer, so the values are only a representation of what the distribution may look like along the length of a buffer tube. Also, the experimental measurement technique can have some inaccuracy due to the way the EFL is sampled and the individual measurements are made. The technique consists of cutting the tube into short sections at discrete locations, and measuring the length of the fiber in each section. The shape of the EFL curve depends on the frequency of the sampling, and the accuracy of the handling and measurement of each section.

The numerical simulations did not take any thermal effects into consideration for the computation of strain. Thermal and material effects, such as expansion and contraction, and material crystallinity and shrinkage, influence the distribution of EFL within the tube. Also, relaxation of the material while it is on the reel has an effect on the EFL. In addition, the

EFL curve predicted by the model represents the EFL while the buffer tube is still on the reel in a strained state. The measurements are taken when the buffer tube has been removed from the reel, and cut into pieces. There is the possibility that the EFL could change in this situation, and the values could not be directly compared to those predicted by the model. It is assumed that the EFL is locked in while the buffer tube is on the reel, and it does not change much when it is taken off, the model provides a reasonable approximation. Various thermal and material effects can be taken into consideration in the model, assuming the appropriate material data can be provided.

Another simulation was performed to compare with an experimental buffering trial conducted with a constant tension of 10.0 N. In this case the shape of the EFL curve predicted by the model is not the same as the experiment, so the initial EFL value can not be determined by matching the curves. Figure 31 shows the EFL curve from the experiment and from the model, calculated with an initial EFL of 0.52%. The model shows that the entire EFL curve shifts up due to less tension on the tube. This is reasonable since less strain on the tube would allow more EFL to accumulate, and would not greatly reduce the EFL already present. The experimentally measured EFL shows a very low EFL in the tube near the surface of the reel. This level of EFL seems to indicate that a tension higher than 10.0 N was on the tube at the beginning of the trial. The process may be slightly unstable at the beginning when the first few layers are going onto the reel, and transients are still present. Also, it is possible that for very low tensions the thermal effects on the material become more significant.

Figure 32A shows a comparison of the EFL for the 10.0 N and 30.0 N tension cases, for both the model and experiment. The comparison between FEA and experiment shows the

same trend in EFL except for the beginning portion of the experimental curve for the 10.0 N case.

Another case that was compared included a thick compliant layer on the reel surface, and a linearly decaying tension. The material properties for the regular material were taken to be the same as in the simulations discussed previously, and the compliant layer had a modulus of 12.0 MPa, and a Poisson's ratio of 0.09. The first two layers of elements were taken to be the compliant material. The tension was decayed linearly from a starting value of 28.0 N to 11.0 N. Figure 32B shows the EFL obtained from the model, and the experimentally measured distribution. An initial EFL of 0.65% was chosen for the model calculations. The trend of EFL is predicted quite well in this case, although there is a slight deviation from the measured values. There are several uncertainties in this case that could result in some differences in the measured and predicted EFL values. The properties of the actual compliant layer were not known, and the assumption of it being a linear elastic material may not be sufficient. Also, the tension in the experiment was adjusted manually in a step-wise manner, which may have introduced transients into the system and could have caused a deviation from the linear decay curve assumed.

The comparisons made between the model and the experiments show reasonably good agreement in the trend of the EFL distribution. This allows the model to be used in a predictive capacity to help determine the most favorable conditions for obtaining a uniform EFL distribution. Although there may be some uncertainties in material properties or other process parameters, the model can be used to help bracket a solution. The numerical simulations could be supplemented with carefully controlled experiments to help tune the solution further.